

7 data processing means for processing measured data from said
 8 current measuring means,
 9 wherein said electron beam irradiation means includes collimator
 10 means for collimating the electron beam to a parallel beam and means for
 11 changing an acceleration voltage of the electron beam and wherein said
 12 data processing means includes means for obtaining an information related
 13 to a structure of the sample in a depth direction on the basis of [a
 14 difference in transmittivity] changes of the measured current of said
 15 current measuring means caused by a penetration depth of the electron
 16 beam for the sample when the latter is scanned with different acceleration
 17 voltages.

REMARKS

This application claims benefit of priority under 35 U.S.C. §119 based on Japanese applications 11-315320 filed November 5, 1999, 2000-191817 filed June 26, 2000, and 2000-311196 filed October 11, 2000. The priority documents were filed on February 12, 2001. Acknowledgment of the claim of priority and receipt of the priority documents is again respectfully requested.

Applicants elected with traverse the species of Figure 1 in response to the restriction requirement mailed on February 14, 2002. In making that election, and in compliance with the requirement to do so, Applicants listed claims 1, 4 to 9, 13, and 28 to 33 as readable on the elected species. The Examiner states that he agrees that claim 1 is generic and that the election requirement will be withdrawn at such time as a generic claim is found allowable. However, the examiner again withheld from examination, and again without explanation, claims 5 to 8, 13, and 28 to 32 and now adds claim 9 to that list. Applicants believe that they are entitled at least to an examination on the merits of claims 5 to 9, 13, and 28 to 32 along with claims 1, 4, and 33, which examination is respectfully requested.

The analysis of the several drawing figures as set out on pages 11 and 12 of the Amendment filed August 30, 2002, is incorporated herein by reference. The following is an analysis of the claims which read on the elected Figure 1 but which the Examiner has incorrectly withheld from consideration.

Claim 5 is dependent on claim 1 and recites that the data processing means 10 (Figure 1) includes area calculation means. This as explained in the specification and as would be understood by one skilled in the art is a program which runs on the data processing means 10.

Claim 6 is dependent on claim 5 and recites that the data processing means 10 (Figure 1) includes distance calculation means. This as explained in the specification and as would be understood by one skilled in the art is a program which runs on the data processing means 10.

Claim 7 is dependent on claim 1 and recites that the electron beam irradiation means 1, 3, 4, 11 (Figure 1) includes means for setting the spot size of the electron beam. This is a function of condenser lens 3 and aperture plate 4 as controlled by the beam control portion 11.

Claim 8 is dependent on claim 1 and recites that the data processing means 10 (Figure 1) includes means for determining the value of current. As shown in Figure 1, the data processing means 10 receives a measure of current from the ammeter 9.

Claim 9 is dependent on claim 1 and recites that the data processing means 10 (Figure 1) includes means of comparing a current value measured (by ammeter 9) to positional coordinates (as measured by the moving distance measuring device 8) when the wafer under test is irradiated with an electron beam.

Claim 13 is dependent on claim 1 and recites tilting means for tilting a sample stage on which the sample under test is mounted. As shown in Figure 1, the sample under test 5 is mounted on a movable stage 6. As is conventional in electron beam systems, the movable stage 6 is movable in multiple directions and rotatable about multiple axes.

Claim 28 is dependent on claim 1 and recites that the means for obtaining information related to the structure in the depth direction includes means for obtaining three-dimensional configuration of a through-hole. This is a function of the current measured by the ammeter 9 (Figure 1) and the processing of the measured current by the data processor 10.

Claim 29 is dependent on claim 28 and recites means for tilting a sample stage on which the sample under test is mounted. As shown in Figure 1, the sample under test 5 is mounted on a movable stage 6. As is conventional in electron beam systems, the movable stage 6 is movable in multiple directions and rotatable about multiple axes.

Claim 30 is dependent on claim 1 and recites that the means for obtaining information related to the structure in the depth direction includes means for detecting deviation of a circuit pattern. This is a function of the current measured by the ammeter 9 (Figure 1) and the processing of the measured current by the data processor 10.

Claim 31 is dependent on claim 30 and recites that the means for detecting deviation of circuit pattern includes means for evaluating a deviation in circuit patterns in respective layers. Again, this is a function of the current measured by the ammeter 9 (Figure 1) and the processing of the measured current by the data processor 10.

Finally, claim 32 is dependent on claim 30 and recites means for taking in information in respective circuit patterns from CAD data. As is conventional, the data processing means 10 (Figure 1) includes data storage in which the CAD data is stored.

In view of the foregoing, it is again respectfully submitted that Applicants are entitled to an examination on the merits of at least claims 5 to 9, 13, and 28 to 32 along with claims 1, 4 and 33.

The Examiner again objects to the drawings under 37 C.F.R. §1.83(a) as failing to show every feature of the invention specified in the claims. This is a repetition of the Examiner's objection as set out in the Office Action mailed

May 2, 2002, to which a response was made in the Amendment filed on August 30, 2002, at pages 13 to 16. The Examiner has failed to acknowledge that response. The response is incorporated herein by reference. No correction or amendment to the drawings is believed necessary.

The Examiner rejects claims 1, 4 and 33 under 35 U.S.C. §112, second paragraph, as being indefinite, saying that, as to claim 1, it is unclear what “an information related to a structure of the sample in a depth direction on the basis of a difference in transmittivity of the electron beam for the sample when the latter is scanned with different acceleration voltages” represents. The Examiner then provides a partial answer saying that “It appears that the information is related to the measured current from the ammeter (9).” This statement, however, seems to suggest that the Examiner has failed to read and understand the specification which clearly describes the functions of not only the ammeter 9, but also the data processor 10 and the beam control portion 11. More particularly, the process is illustrated in, for example, Figures 6(a) and 6(b) and described on pages 26 to 28 of the specification, among other places in this patent application. Reconsideration and withdrawal of the rejection is therefore respectfully requested.

Claim 1 has been amended to further clarify the basis of the operation of the invention. More particularly, it may be, based on the Examiner’s statements, that there has been a misunderstanding that the current measuring means measures electron beam current transmitted *through* a semiconductor wafer. In this invention, and also in the Yoshizawa et al. patent, an ammeter is connected to a substrate of the tested device for detecting a substrate current *induced* by radiation of a primary electron beam through some physical mechanisms.

If acceleration voltage of the electron beam is changed as in the present invention, penetration depth of electrons is changed according to a difference in transmittivity of the electron beam. Due to the penetration depth change, the distance between penetrated electrons and the back surface of the substrate is changed, resulting in changes in induced resistance and capacitance which, in turn, influences the substrate current to change. Additionally, materials at which the

electron beam is penetrated change the amount of secondary electrons generated which influences the substrate current to change. Claim 1 has, therefore, been amended to change "a difference in transmittivity of electron beam" to "changes of the measured current of said current measuring means caused by the penetration depth of the electron beam—.

Claims 1, 4 and 33 were additionally rejected under 35 U.S.C. §112, first paragraph, as containing subject matter which is not described in the specification in such a way as to enable one skilled in the art to which it pertains to make and/or use the invention. This rejection is respectfully traversed.

The Examiner raises two grounds upon which he bases his rejection. First, the Examiner alleges that it is unclear from the specification how the moving distance measuring device (8) is used for measuring distance of the movable stage (6) "when this device is not connected to the moving stage (6)". It is assumed by this statement that the Examiner has only looked at Figure 1 which is a high level block diagram. In that figure, the moving distance measuring device 8 is shown proximate to the movable stage 6, and one skilled in the art would immediately recognize that there are many ways in which the measurement can be made.

Attached is a copy of pages 360 and 361 of *VLSI Handbook*, edited by Normal G. Einspruch, Academic Press (1985), which describes on page 361 that stage motion is monitored by laser interferometer. In fact, this is the method used in the subject invention, as clearly set out on page 23, lines 16 to 19, of the specification.

Attached are copies of U.S. Patent Nos. 6,472,672 and 6,486,955, which provide but two examples of stage movement measurement devices based on the interferometer method. If the Examiner wants a line drawn between the distance measuring device 8 and the movable stage 6, he is referred to Figures 25, 35, 37, 40, and 45 of this patent application which shows such a line. These figures constitute part of the Applicants' original invention disclosure.

The second point raised by the Examiner is substantially identical to his earlier rejection of the claims under 35 U.S.C. §112, second paragraph, which has been answered by the response to that rejection. Withdrawal of the rejection under

35 U.S.C. §112, first paragraph, is therefore respectfully requested.

Claim 1 was rejected under 35 U.S.C. §102(b) as anticipated by U.S. Patent No. 4,980,639 to Yoshizawa et al. This rejection is a repeat of the rejection made in the Office Action mailed May 2, 2002, and responded to in detail in the amendment filed on August 30, 2002. However, in repeating the rejection, the Examiner has failed to acknowledge the response in the amendment filed on August 30, 2002. The rejection is again traversed, and the previous response is incorporated herein by reference.

Again, for the benefit of the Examiner, the disclosed and claimed invention is directed to a semiconductor device tester in which current flowing through a semiconductor device irradiated with an electron beam is measured. The purpose of this measurement is to determine the structure of the sample in the depth direction. This allows for the determination of the area and diameter of a bottom of a contact-hole or a three-dimensional configuration thereof at high speed.

The semiconductor device tester according to the present invention includes electron beam irradiation means 1 for irradiating a semiconductor device 5 as a sample under test with electron beam while scanning the semiconductor device, current measuring means 9 for measuring current produced in the sample by irradiation of electron beam and data processing means 10 for processing measured data from the current measuring means. The electron beam irradiation means includes collimator means 3 for collimating the electron beam to parallel beam and means 11 for changing acceleration voltage of electron beam. The data processing means 10 includes means for obtaining an information related to a structure of the sample in a depth direction on the basis of a difference in transmittivity of electron beam for the sample when the latter is scanned with different acceleration voltages.

Yoshizawa et al. disclose a method and apparatus for testing electrical characteristics of an integrated electronic device, such as leakage current and capacitance. While Yoshizawa et al. use an electron beam irradiation means and a current measuring means, as does the claimed invention, they do not generate or

process the same data as do the Applicants. In Applicants' invention, the acceleration voltage of the electron beam is changed and the data generated by this operation is processed by the data processing means to obtain "information on the structure of the sample in a depth direction on the basis of changes of the measured current of said current measuring means caused by a penetration depth of the electron beam for the sample when the latter is scanned with different acceleration voltages."(Emphasis added). In contrast, the materials of the wafer surface only are irradiated with an electron beam in Yoshizawa et al. In other words, what Applicants have accomplished with their invention is obtaining information related the structure of the sample in the depth direction. As clearly stated on page 1, lines 20 and 21, of the specification, "In order to optimize etching condition, it is necessary to detect an outer and inner configurations of a contact-hole or a state of a bottom of the contact-hole." This is what the claimed invention does.

The Examiner has made a very superficial comparison of the claimed invention to the structure shown in the patent to Yoshizawa et al.; however, this comparison omits specific limitations recited in claim 1. The superficial similarity of Yoshizawa et al. to the structure shown in the several embodiments of the disclosed invention is due to the fact that Scanning Electron Microscope (SEM) technology is used; however, Yoshizawa et al. were not the first to use SEM technology to measure integrated circuit characteristics. What is important to understand is what is being measured and how that characteristic is measured. In the present case, Yoshizawa et al. do not measure what Applicants measure and Applicants perform their measurement in a manner different than how Yoshizawa et al. perform their measurement.

Claim 1 specifically recites "said data processing means includes means for obtaining an information related to a structure of the sample in a depth direction on the basis of changes of the measured current of said current measuring means caused by the penetration depth of the electron beam for the sample when the latter is scanned with different acceleration voltages." This is not

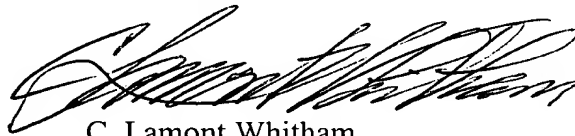
shown, nor is it suggested, by Yoshizawa et al. Therefore, the rejection under 35 U.S.C. §102(b) is in error and should be withdrawn.

In view of the foregoing, it is respectfully requested that the application be reconsidered, that claims 1 to 35 be allowed, and that the application be passed to issue.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

A provisional petition is hereby made for any extension of time necessary for the continued pendency during the life of this application. Please charge any fees for such provisional petition and any deficiencies in fees and credit any overpayment of fees to Attorney's Deposit Account No. 50-2041.

Respectfully submitted,

A handwritten signature in black ink, appearing to read 'C. Lamont Whitham', is written over a horizontal line.

C. Lamont Whitham
Reg. No. 22,424

Whitham, Curtis & Christofferson, P.C.
11491 Sunset Hills Road, Suite 340
Reston, VA 20190
Tel. (703) 787-9400 or (703) 391-2510
Fax. (703) 787-7557 or (703) 391-9035

Clean Copy of Amended Claim 1

1 1. A semiconductor device tester comprising:
2 electron beam irradiation means for irradiating a semiconductor
3 device as a sample under test with an electron beam while scanning the
4 semiconductor device;
5 a current measuring means for measuring current flowing through
6 the semiconductor resulting from irradiation by the electron beam; and
7 data processing means for processing measured data from said
8 current measuring means,
9 wherein said electron beam irradiation means includes collimator
10 means for collimating the electron beam to a parallel beam and means for
11 changing an acceleration voltage of the electron beam and wherein said
12 data processing means includes means for obtaining an information related
13 to a structure of the sample in a depth direction on the basis of changes of
14 the measured current of said current measuring means caused by a
15 penetration depth of the electron beam for the sample when the latter is
16 scanned with different acceleration voltages.